

AbstractID: 11850 Title: Feasibility of Utilizing Pneumatic Abdominal Bellows for Quantitative 4DCT

**Purpose:** To determine if a breathing surrogate can be utilized in place of a spirometer for quantifying 4DCT.

**Method and Materials:** Using an established four dimensional computed tomography (4DCT) protocol, forty one patient data sets were acquired while measuring the breathing cycle using both spirometry and a pneumatic abdominal bellows. The image datasets were segmented to find the total lung volume (air content) and the bellows internal pressure signal was normalized into tidal volume for the entire scan session by correlating against the spirometry data subdivided into sequential 18.75 s periods. A threshold tolerance of 2% in the correlation of each 18.75s period was applied to ignore times where the spirometry apparatus leaked or failed to record meaningful data. This threshold provided a conservative criterion in identifying regions of abnormal spirometry response. The tidal volume was compared against the air content to validate the normalized bellows signal.

**Results:** The 2% threshold correlation excluded the time period where the spirometry signal was unreliable. Overall, 86% of the time periods are within the 2% threshold, providing sufficient data to determine the relationship between tidal volume and air content. The measured ratio of air content to tidal volume was  $1.11 \pm 0.08$  for all patients. The theoretical value is 1.11 based on the air density differences between room air and air inside the lungs.

**Conclusion:** The bellows and spirometry data correlated well when the spirometry apparatus was functioning properly. The ratio of air content to spirometry-measured tidal volume was exactly that expected using the ratio of air densities inside and outside the lungs. These data support the use of a non-spirometry method of breathing gating such as the pneumatic bellows as long as the entire lungs are scanned to provide the air content data.

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